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VERIFICATION OF SEVERE LOCAL STORM CONDITIONAL PROBABILITY FORECASTS FOR 1975

Donald S. Foster and Ronald M. Reap

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INTRODUCTION

Spring operational severe local storm conditional probability forecast equations, developed by Reap and Foster (1975), were implemented during June 1975. The equations for the spring forecasts were replaced July 1 by summer equations that continued in use through September 1975. The forecasts generated by these equations were distributed to forecast offices nationwide via facsimile and the FAA's request/reply system. They were designed to be used as guidance material for forecasters preparing local and regional forecasts. This paper describes our verification of the severe local storm forecasts. Verification statistics for thunderstorm probability forecasts issued during this period were previously described by Foster and Reap (1976).

SEVERE LOCAL STORM CONDITIONAL PROBABILITY

The severe local storm conditional probability forecasts are forecasts of the probability that a severe local storm will occur if a thunderstorm occurs in that area. The forecast equation was derived by applying multiple screening regression techniques to model predictors archived on magnetic tape and to predictands tabulated from manually-digitized radar (MDR) data and severe local storm reports. The model predictors were 24-hr forecasts from the National Meteorological Center (NMC) six-layer primitive equation model and the Techniques Development Laboratory (TDL) three-dimensional trajectory model. The MDR data were collected from hourly teletype reports and archived on magnetic tape. The data were coded for blocks 74-83 kilometers on a side, whose configuration is shown in figure 1. Severe local storm reports of tornadoes, surface hail $\gtrsim$ 1.9 cm in diameter, wind gusts $\gtrsim$ 93 km per hour and wind damage reports that occurred between hr + 0 min and hr + 59 min in an MDR block were merged with the MDR code reported for the block at hr + 30 min. Because of the time difference between the MDR reports and the storm reports it is possible for the MDR code to be below the thunderstorm threshold at MDR observation time and above the threshold at severe storm time. Therefore, to compensate somewhat for this possible discrepancy, a severe local storm case was defined for verification purposes as a tornado, hailstorm or windstorm that occurred between hr + 0 min and hr + 59 min in a MDR block where an MDR code of 4 or greater was reported at hr -30 min, hr +30 min or hr +90 min. Also, the severe local storm reports must have occurred during the valid time of the forecast which was +3 hours from 0000 GMT. A non-severe local storm case (thunderstorm case) was defined as an MDR code of 4 or greater observed within the period $\pm$ 3 hours from 0000 GMT, and no severe local storms reported.

VERIFICATION METHOD

The data acquired for verification included for each MDR block all days on which a thunderstorm occurred as defined above, within the forecast valid time, whether or not a severe local storm occurred. First, the MDR data and the severe local storm data were merged on tape for each MDR block. Next, an intermediate data set was created composed of individual daily records. These records contained the forecast conditional probability value and the highest category of severe local storm (tornado, windstorm and hail in descending order), reported in the MDR block during the period $\pm$ 3 hours from 0000 GMT. Also included was the highest MDR code reported in the hour prior to, the hour of, or the hour after the severe report. When no severe events were reported, the highest MDR code reported in the 6-hr period was recorded. Next, verification statistics were computed from the intermediate data set and tabulated for examination.

There are a number of verification statistics and scores available for measuring the accuracy of probability forecasts. We decided on two scores that we believe provide sufficient information for a comprehensive analysis of the forecasts. One score, F, may be considered a measure of bias or forecast reliability. The other score, P, is one-half the probability score defined by Panofsky and Brier (1958) and measures the mean squared error of the forecasts. It is a measure of both the reliability and the resolution of the forecasts. Resolution means the extent to which the individual probability forecast approaches the correct values of zero or one.

These scores were computed for individual MDR blocks for each of 10 conditional probability categories, for each MDR block for all categories combined, and for the whole MDR grid for all categories. Limits of the 10 conditional probability categories were as follows: 0.00 to 0.09, 0.10 to 0.19, 0.20 to 0.29,.....0.90 to 0.99. The basic tabulation consisted of the number of thunderstorm cases (i.e., number of forecasts) and the number of severe local storm cases for each MDR grid block and for each category. From this tabulation the F and P scores were computed for each MDR block and for each forecast probability category. The F score is defined as:

$$F_i = \frac{(N_i \times R_i) - O_i}{N_i} \times 100$$

where

N_i= Number of thunderstorm cases in category i,

R_i= Average conditional probability for N_i thunderstorm cases,

O_i= Number of severe local storm cases in the N_i cases.

For example, if there were 100 thunderstorm cases within the 0.50 to 0.59 conditional probability category with a mean conditional probability of 0.55, and there were 55 severe local storm cases, the F score would be 0 percent (perfect reliability). If there were no severe storm cases, the F score would be +55% (overforecast). If the average conditional probability in a category was 0 percent and there were 55 severe local storm cases, F would be -55% (underforecast). The range of F is from -100 to +100 percent, with 0 being a perfect score, i.e., no bias.

The P score as used here is defined as:

$$P = \frac{1}{N} \sum_{i=1}^{N} (R_i - I_i)^2 \times 100$$

Here R_i is the conditional probability for the ith forecast and I_i is the observation, namely 1 if a severe local storm was observed and 0 otherwise. Usually the P score is not multiplied by 100. It is done so here to save space in the computer listings.

VERIFICATION STATISTICS

Two forecast equations were developed, one for the spring season and one for the summer season. For this reason the verification statistics are derived accordingly. Table 1 shows a summary of statistics for each forecast category for the entire MDR grid for the spring period which, unfortunately, included only 19 days in June. Table 2 shows a similar summary for the 88-day summer period, July through September. F scores of +1 for June and -1 for July through September indicate very good forecast reliability. P scores of 6 and 3 showed very good forecast resolution. Average forecast probabilities of 0.08 and 0.02 were very close to the actual probabilities of occurrence of 0.06 and 0.03. A broad glance indicates the forecast equations performed very well.

For a closer examination Table 3 shows day by day statistics for the whole MDR grid for the spring period. Table 4 shows similar data for each day of the summer period. The number of thunderstorm cases, the number of severe local storm cases, an F score, and a P score are shown for nine categories. The tenth category, 0.90 to 0.99 was omitted to conserve table space. No forecasts were made in that category. The total number of severe local storm cases for each day is tabulated in the fourth column from the right. To the right of this column is tabulated the number of thunderstorm cases expected to have severe local storms each day. To the right of this column are the F score and P score for the whole MDR grid for each day. Here we begin to see day to day variations in the F score indicating that on some days severe local storms were either under or overforecast. Fluctuations in the P score also indicate that some days are better than others. Scores appear to fluctuate more in June than in late summer.

For an even closer examination, statistics were tabulated for each MDR block for both the spring and summer periods. The length of these tables precludes including them in this report. As an alternative, the F scores and P scores for each MDR block during the spring period are plotted in figures 2 and 3. Summer period scores are shown in figures 4 and 5. Here we observe even greater fluctuations in scores from one block to another. In addition, greater fluctuations are observed in the northern states than in the gulf coastal area.

SUMMARY AND FUTURE PLANS

We were satisfied with the verification statistics for the severe local storm conditional probability forecasts over the whole MDR grid for whole seasons. However, on a day-to-day and a block-by-block basis, fluctuations from the overall scores indicate there is considerable room for improvement in the forecast equations, reflecting the need for improved resolution in the operational numerical models that generate the predictors.

Future plans call for updating the predictand data by including both 1974 and 1975 MDR and severe local storm data in the development sample. We have tabulated monthly relative frequencies of severe local storms for a five year period and are experimenting with methods to incorporate these data into the equations. We have developed about a dozen new derived predictors that represent large scale meteorological features described in the literature as associated with severe local storm outbreaks. Also, a severe local storm conditional probability equation has been developed for the winter season, January through March. Finally, we have begun to archive trajectory model output derived from LFM forecast parameters to use in developing future probability forecast equations.

REFERENCE

Foster, D. S., and R. M. Reap, 1976: Verification of thunderstorm probability forecasts for the summer of 1975, TDL Office Note 76-5, National Weather Service, NOAA, Silver Spring, Md., 25 pp.

Panofsky, H. A., and G. W. Brier, 1958: Some Applications of Statistics to Meteorology. The Pennsylvania State University, University Park, Pa., 224 pp.

Reap, R. M., and D. S. Foster, 1975: New operational thunderstorm and severe storm probability forecasts based on model output statistics (MOS). Preprints Ninth Conference on Severe Local Storms, Norman, Oklahoma, Am. Meteor. Soc., Boston, Mass., 58-63.

TABLE 1. VERIFICATION SUMMARY OF 24-HOUR SEVERE LOCAL STORM CONDITIONAL PROBABILITY FORECASTS FOR 19 DAYS DURING THE PERIOD 75060100 THROUGH 75063000. FORECAST VALID TIME IS PLUS OR MINUS 3 HOURS FROM 0000 GMT.

PROBABILITY CATEGORY	NR OF FCSTS	FCST PERCENT	CUM FCSTS	CUM FCST PERCENT	FCSTS W/OCC	FCST W/O PERCENT	CUM FCSTS W/OCCURR	CUM F W/O PERCENT	EXPECTED FCSTS W/O	AVG FCST PROB	OB PROB OF OCC	F SCORE	P SCORE
0.90 - 0.99	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.80 - 0.89	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.70 - 0.79	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.60 - 0.69	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.50 - 0.59	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.40 - 0.49	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.30 - 0.39	41	1.5	41	1.5	13	7.5	13	7.5	14	0.34	0.32	+2	22
0.20 - 0.29	238	8.7	279	10.2	59	33.9	72	41.4	57	0.24	0.25	-1	18
0.10 - 0.19	512	18.8	791	29.1	43	24.7	115	66.1	75	0.15	0.08	+6	8
0.0 - 0.09	1931	70.9	2722	100.0	59	33.9	174	100.0	67	0.03	0.03	0	3
TOTAL	2722	100.0			174	100.0			214	0.08	0.06	+1	6

Explanation of column headings from left to right for tables 1 and 2:

PROBABILITY CATEGORY - Conditional probability category,
NR OF FCSTS - Number of forecasts made in each category,
FCST PERCENT - Percent of forecasts made in each category,
CUM FCSTS - Cumulated forecasts from high to low categories,
CUM FCST PERCENT - Cumulated percent of forecasts from high to low categories,
FCSTS W/OCC - Forecasts with severe local storm occurrences,
FCSTS W/O PERCENT - Percent of forecasts with severe local storm occurrences,
CUM FCSTS W/OCCURR - Cumulated forecasts with severe local storm occurrences,
CUM F W/O PERCENT - Cumulated percent of forecasts with severe local storm occurrences,
EXPECTED FCSTS W/O - Expected number of forecasts with severe local storm occurrences,
AVG FCST PROB - Average forecast conditional probability,
OB PROB OF OCC - Observed conditional probability of severe local storm occurrences,
F SCORE - F score for each category,
P SCORE - P score for each category.

TABLE 2. VERIFICATION SUMMARY OF 24-HOUR SEVERE LOCAL STORM CONDITIONAL PROBABILITY FORECASTS FOR 88 DAYS DURING THE PERIOD 75070100 THROUGH 75093000. FORECAST VALID TIME IS PLUS OR MINUS 3 HOURS FROM 0000 GMT.

PROBABILITY CATEGORY	NR OF FCSTS	FCST PERCENT	CUM FCSTS	CUM FCST PERCENT	FCSTS W/OCC	FCST W/O PERCENT	CUM FCSTS W/OCCURR	CUM F W/O PERCENT	EXPECTED FCSTS W/O	AVG FCST PROB	OB PROB OF OCC	F SCORE	P SCORE.2
0.90 - 0.99	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.80 - 0.89	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.70 - 0.79	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.60 - 0.69	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.50 - 0.59	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.40 - 0.49	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.30 - 0.39	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0.0		
0.20 - 0.29	1	0.0	1	0.0	1	0.3	1	0.3	0	0.20	1.00	-80	64
0.10 - 0.19	262	2.2	263	2.3	25	8.2	26	8.5	33	0.13	0.10	+3	9
0.0 - 0.09	11425	97.7	11688	100.0	280	91.5	306	100.0	205	0.02	0.02	-1	2
TOTAL	11688	100.0			306	100.0			238	0.02	0.03	-1	2

TABLE 3. DAILY VERIFICATION OF 24-HOUR SEVERE LOCAL STORM CONDITIONAL PROBABILITY FORECASTS FOR THE DATES INDICATED. FORECAST VALID TIME IS PLUS OR MINUS 3 HOURS FROM 0000 GMT.

DATE	PROB CAT .00-.09				PROB CAT .10-.19				PROB CAT .20-.29				PROB CAT .30-.39				PROB CAT .40-.49				PROB CAT .50-.59				PROB CAT .60-.69				PROB CAT .70-.79				PROB CAT .80-.89				SUM	SUM	F	P
	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	O	X	S	S
604	55	1	+1	2	13	1	+10	8	25	8	-9	23	1	0	+32	10	0	0			0	0			0	0			0	0			0	0			10	10	-1	8
610	95	1	+5	1	72	5	+8	7	0	0			0	0			0	0			0	0			0	0			0	0			0	0			6	16	+6	4
612	133	4	0	3	15	0	+15	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			4	6	+1	3
613	102	2	+1	2	10	0	+13	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	5	+2	2
614	48	1	+1	2	39	8	-6	16	28	11	-14	25	0	0			0	0			0	0			0	0			0	0			0	0			20	14	-5	13
615	84	4	-2	5	18	1	+10	6	36	5	+11	13	16	6	-4	24	0	0			0	0			0	0			0	0			0	0			16	20	+2	9
616	34	5	-12	14	16	2	+1	11	1	0	+23	5	0	0			0	0			0	0			0	0			0	0			0	0			7	3	-7	13
617	47	0	+3	0	22	1	+11	5	45	10	+3	17	21	5	+11	19	0	0			0	0			0	0			0	0			0	0			16	23	+5	10
618	46	1	0	2	33	1	+13	5	13	1	+15	9	0	0			0	0			0	0			0	0			0	0			0	0			3	9	+7	4
619	61	4	-2	6	31	3	+4	9	6	1	+9	16	3	2	-35	35	0	0			0	0			0	0			0	0			0	0			10	10	0	8
620	98	8	-5	7	30	1	+13	5	35	15	-18	27	0	0			0	0			0	0			0	0			0	0			0	0			24	17	-4	11
621	126	11	-5	8	43	5	+4	10	24	5	+2	17	0	0			0	0			0	0			0	0			0	0			0	0			21	17	-2	10
622	156	3	+1	2	76	8	+5	10	23	3	+9	12	0	0			0	0			0	0			0	0			0	0			0	0			14	22	+3	5
623	163	6	0	3	24	2	+4	8	2	0	+21	5	0	0			0	0			0	0			0	0			0	0			0	0			8	10	+1	4
625	150	2	+3	1	20	2	+2	9	0	0			0	0			0	0			0	0			0	0			0	0			0	0			4	9	+3	2
626	144	3	+1	2	6	1	-4	12	0	0			0	0			0	0			0	0			0	0			0	0			0	0			4	5	-1	2
627	129	1	+2	1	24	1	+9	5	0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	7	+3	2
628	164	0	+4	0	18	1	+7	6	0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	8	+4	1
630	96	2	+1	2	2	0	+11	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	3	+1	2

Explanation of column headings from left to right for tables 3 and 4:

DATE - Month and day,
N - Number of forecasts made in conditional probability category .00 - .09 that day,
O - Number of forecasts in conditional probability category .00 - .09 with severe local storm occurrences,
F - F score for category .00 - .09 that day,
P - P score for category .00 - .09 that day.
This sequence is repeated through category .80 - .89.
SUM O - Sum of the forecasts with severe local storm occurrences that day,
SUM X - Sum of the forecasts expected to have severe local storm occurrences that day,
F S - F score that day,
P S - P score that day.

TABLE 4. DAILY VERIFICATION OF 24-HOUR SEVERE LOCAL STORM CONDITIONAL PROBABILITY FORECASTS FOR THE DATES INDICATED. FORECAST VALID TIME IS PLUS OR MINUS 3 HOURS FROM 0000 GMT.

DATE	PROB CAT .00-.09				PROB CAT .10-.19				PROB CAT .20-.29				PROB CAT .30-.39				PROB CAT .40-.49				PROB CAT .50-.59				PROB CAT .60-.69				PROB CAT .70-.79				PROB CAT .80-.89				SUM	SUM	F	P
	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	O	X	S	S
702	123	0	+1	0	1	0	+10	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	1	+1	0
703	143	0	+1	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	2	+1	0
704	150	14	-8	9	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			14	2	-8	9
705	36	2	-5	5	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	0	-5	5
706	125	11	-6	8	16	1	+7	6	0	0			0	0			0	0			0	0			0	0			0	0			0	0			12	5	-5	8
707	170	7	-1	4	46	3	+6	7	0	0			0	0			0	0			0	0			0	0			0	0			0	0			10	11	+1	4
708	182	8	-2	4	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			8	5	-2	4
709	202	9	-2	4	2	0	+10	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			9	5	-2	4
710	244	13	-2	5	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			13	8	-2	5
711	203	9	-1	4	3	0	+12	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			9	7	-1	4
712	245	3	0	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			3	4	0	1
713	166	2	+1	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	3	+1	1
714	163	8	-4	5	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			8	2	-4	5
715	81	2	-2	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	1	-2	2
716	18	1	-5	6	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	0	-5	6
717	65	0	+1	0	2	0	+11	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	1	+1	0
719	153	2	0	1	7	0	+12	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	3	+1	1
720	219	5	0	2	7	1	-2	12	0	0			0	0			0	0			0	0			0	0			0	0			0	0			6	5	0	2
721	184	7	-2	4	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			7	4	-2	4
722	167	3	0	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			3	4	0	2
723	162	4	0	2	9	0	+11	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			4	5	0	2
724	218	11	-2	5	32	2	+6	6	0	0			0	0			0	0			0	0			0	0			0	0			0	0			13	11	-1	5
725	232	7	0	3	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			7	7	0	3
726	184	1	+1	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	2	+1	1
727	133	1	0	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	1	0	1
729	156	0	+3	0	4	0	+11	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	5	+3	0
730	192	3	0	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			3	3	0	1
731	193	5	-1	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			5	3	-1	2
801	180	2	+1	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	4	+1	1
802	28	0	+1	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0	+1	0
803	87	0	+1	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	1	+1	0
804	193	6	-1	3	3	0	+11	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			6	4	-1	3
805	166	5	-2	3	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			5	2	-2	3
806	167	3	-1	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			3	1	-1	2
807	124	6	-3	5	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			6	2	-3	5
808	92	4	-4	4	6	0	+12	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			4	1	-3	4
809	130	3	-2	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			3	1	-2	2
811	142	1	0	1	7	0	+11	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	2	+1	1
812	147	2	0	1	3	0	+12	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	2	0	1
813	139	7	-3	5	22	1	+10	5	0	0			0	0			0	0			0	0			0	0			0	0			0	0			8	6	-1	5
814	161	11	-4	6	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			11	4	-4	6
815	114	3	-1	3	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			3	2	-1	3
816	166	0	+2	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	3	+2	0
817	189	8	-2	4	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			8	4	-2	4
818	167	6	-1	3	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			6	5	-1	3
819	122	3	-1	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			3	2	-1	2
820	121	0	+2	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	2	+2	0

TABLE 4. (CONTINUED).

DATE	PROB CAT .00-.09				PROB CAT .10-.19				PROB CAT .20-.29				PROB CAT .30-.39				PROB CAT .40-.49				PROB CAT .50-.59				PROB CAT .60-.69				PROB CAT .70-.79				PROB CAT .80-.89				SUM	SUM	F	P
	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	N	O	F	P	O	X	S	S
821	112	5	-3	4	10	1	+2	9	0	0			0	0			0	0			0	0			0	0			0	0			0	0			6	2	-3	5
822	13	0	+3	0	4	1	-10	21	0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	1	0	5
823	59	0	+3	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	2	+3	0
824	115	1	+1	1	2	0	+13	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	2	+1	1
825	119	3	-1	2	35	12	-19	26	1	1	-80	64	0	0			0	0			0	0			0	0			0	0			0	0			16	8	-5	8
826	183	4	0	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			4	4	0	2
827	173	4	0	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			4	3	0	2
828	220	2	0	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	3	0	1
829	213	4	0	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			4	4	0	2
830	167	5	-1	3	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			5	3	-1	3
831	151	2	0	1	1	0	+11	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	2	0	1
901	147	1	0	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	2	0	1
902	97	0	+1	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	1	+1	0
903	76	3	-3	4	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			3	1	-3	4
904	83	2	0	2	11	0	+13	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	4	+2	2
905	149	5	+1	3	1	0	+10	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			5	6	+1	3
906	208	10	-2	5	3	0	+10	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			10	5	-2	4
907	159	0	+1	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	2	+1	0
908	104	1	-1	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	0	-1	1
909	108	1	0	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	1	0	1
910	179	0	+1	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	2	+1	0
911	225	5	0	2	21	2	+1	9	0	0			0	0			0	0			0	0			0	0			0	0			0	0			7	7	0	3
912	96	4	0	4	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			4	4	0	4
913	146	0	+1	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	2	+1	0
914	53	0	0	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0	0	0
915	50	0	0	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0	0	0
916	54	0	0	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0	0	0
917	84	1	0	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	1	0	1
918	81	2	-1	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	1	-1	2
919	73	3	-2	4	4	1	-15	21	0	0			0	0			0	0			0	0			0	0			0	0			0	0			4	2	-2	5
920	50	0	+3	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	1	+3	0
921	97	2	-1	2	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			2	1	-1	2
922	88	0	+1	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	1	+1	0
923	85	1	-1	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	1	-1	1
924	70	1	-1	1	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			1	0	-1	1
925	6	0	0	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0	0	0
926	28	0	0	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0	0	0
927	35	0	+1	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0	+1	0
928	15	0	+2	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0	+2	0
929	61	0	+1	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	1	+1	0
930	49	0	+1	0	0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0			0	0	+1	0

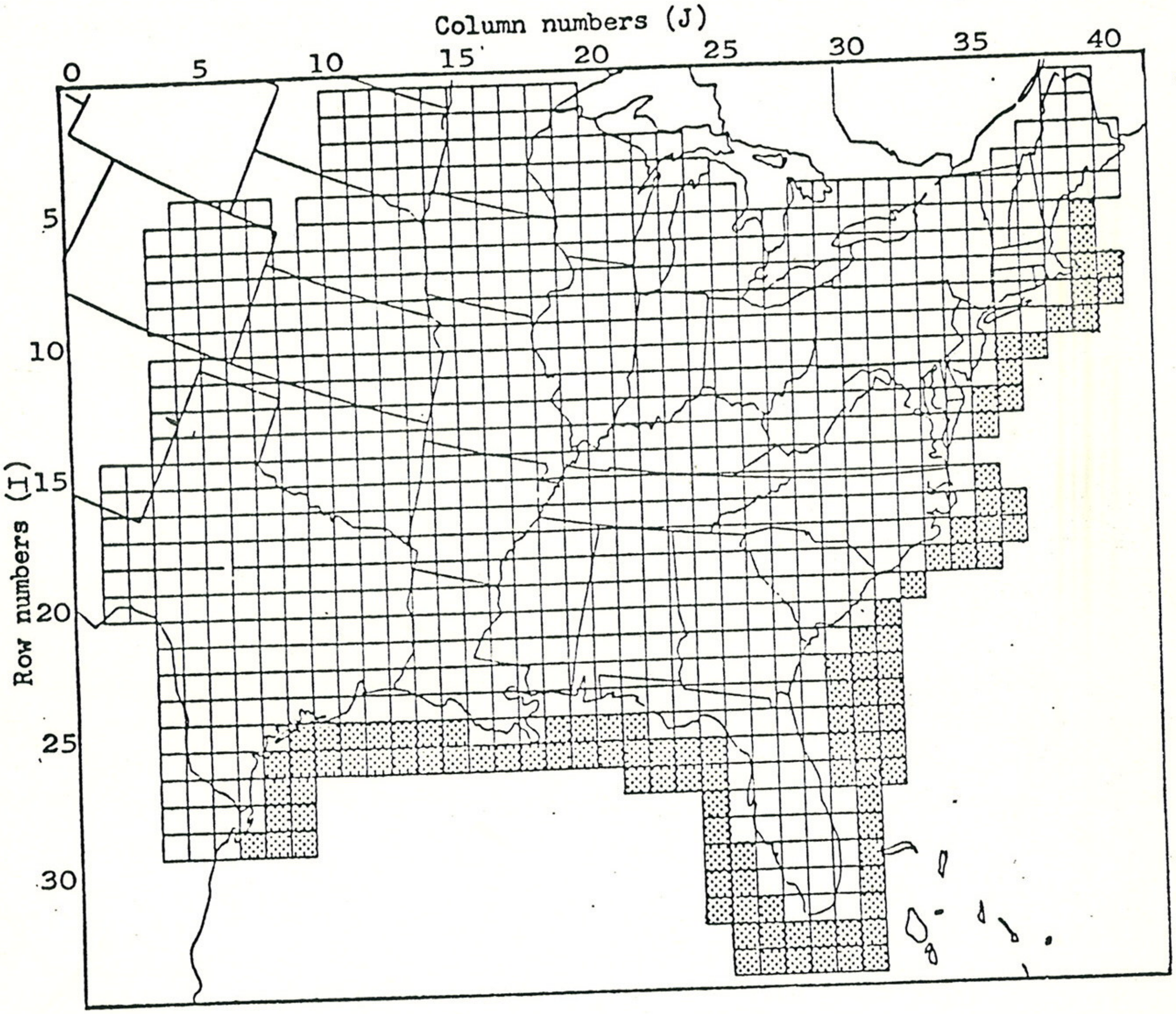

Figure 1. MDR grid region. Data from shaded overwater blocks were not used in the screening regression procedure. Neither were forecasts made for these blocks.

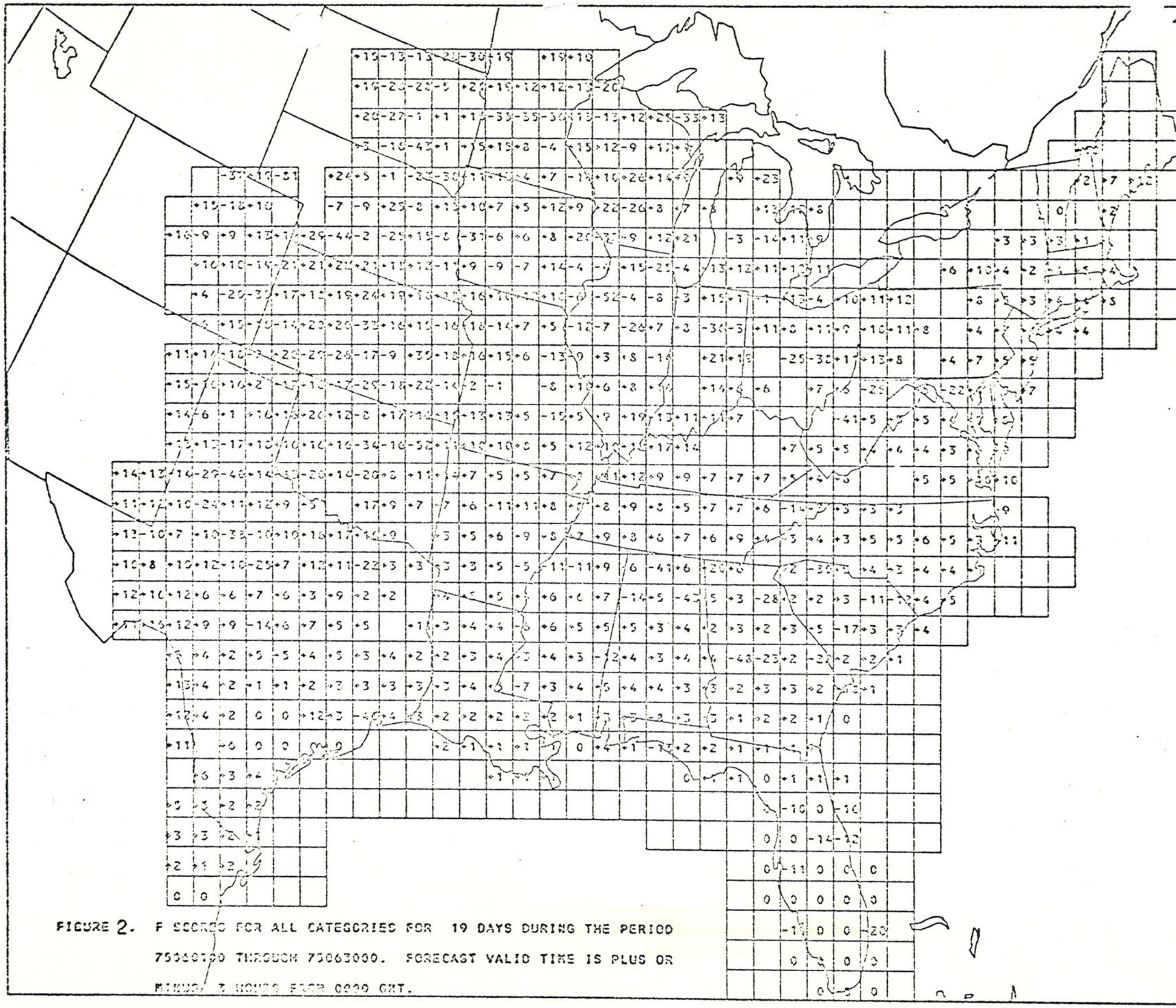

FIGURE 2. F SCORES FOR ALL CATEGORIES FOR 19 DAYS DURING THE PERIOD 75060100 THROUGH 75063000. FORECAST VALID TIME IS PLUS OR MINUS 3 HOURS FROM 0000 GMT.

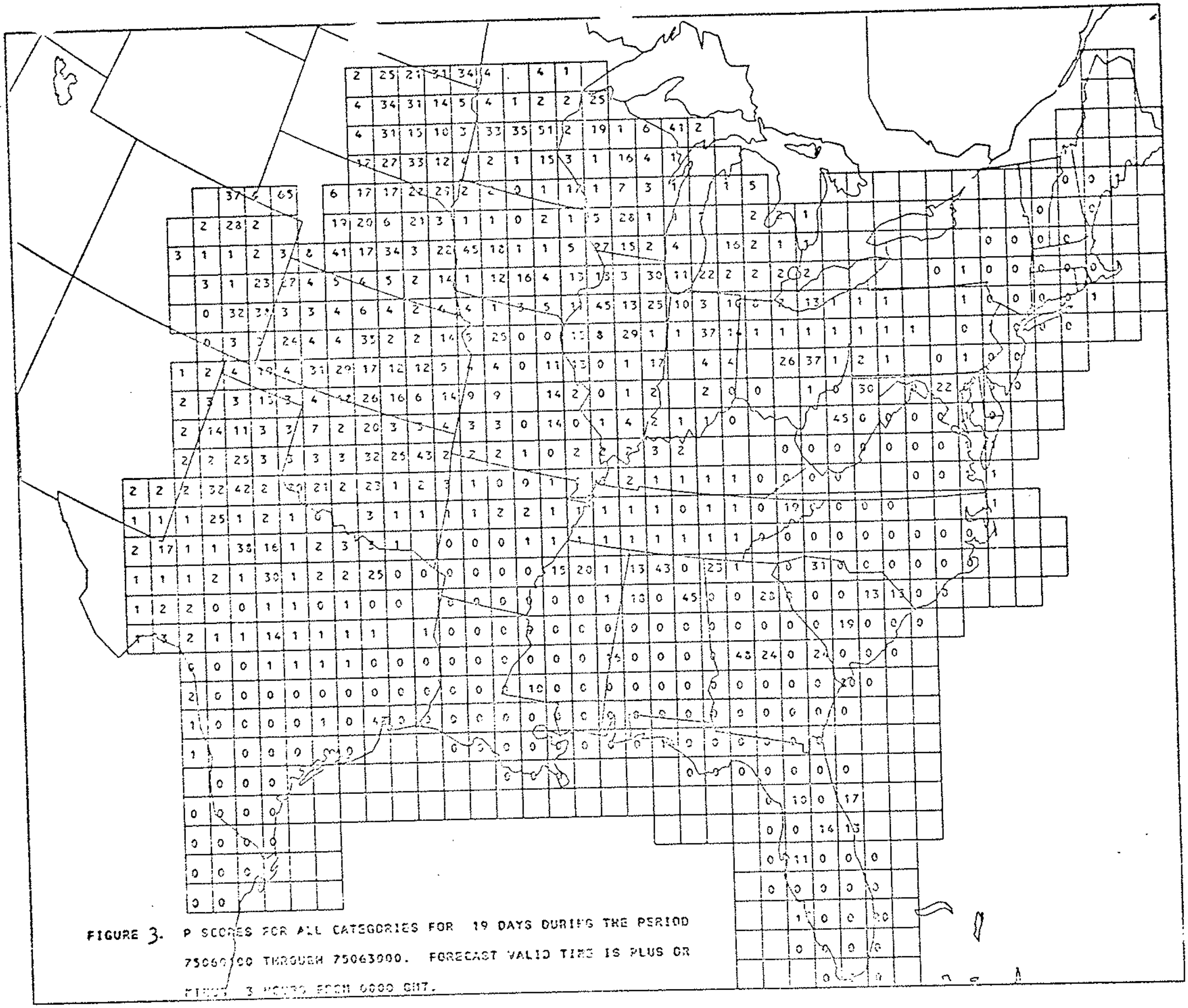

FIGURE 3. P SCORES FOR ALL CATEGORIES FOR 19 DAYS DURING THE PERIOD 75060100 THROUGH 75063000. FORECAST VALID TIME IS PLUS OR MINUS 3 HOURS FROM 0000 GMT.

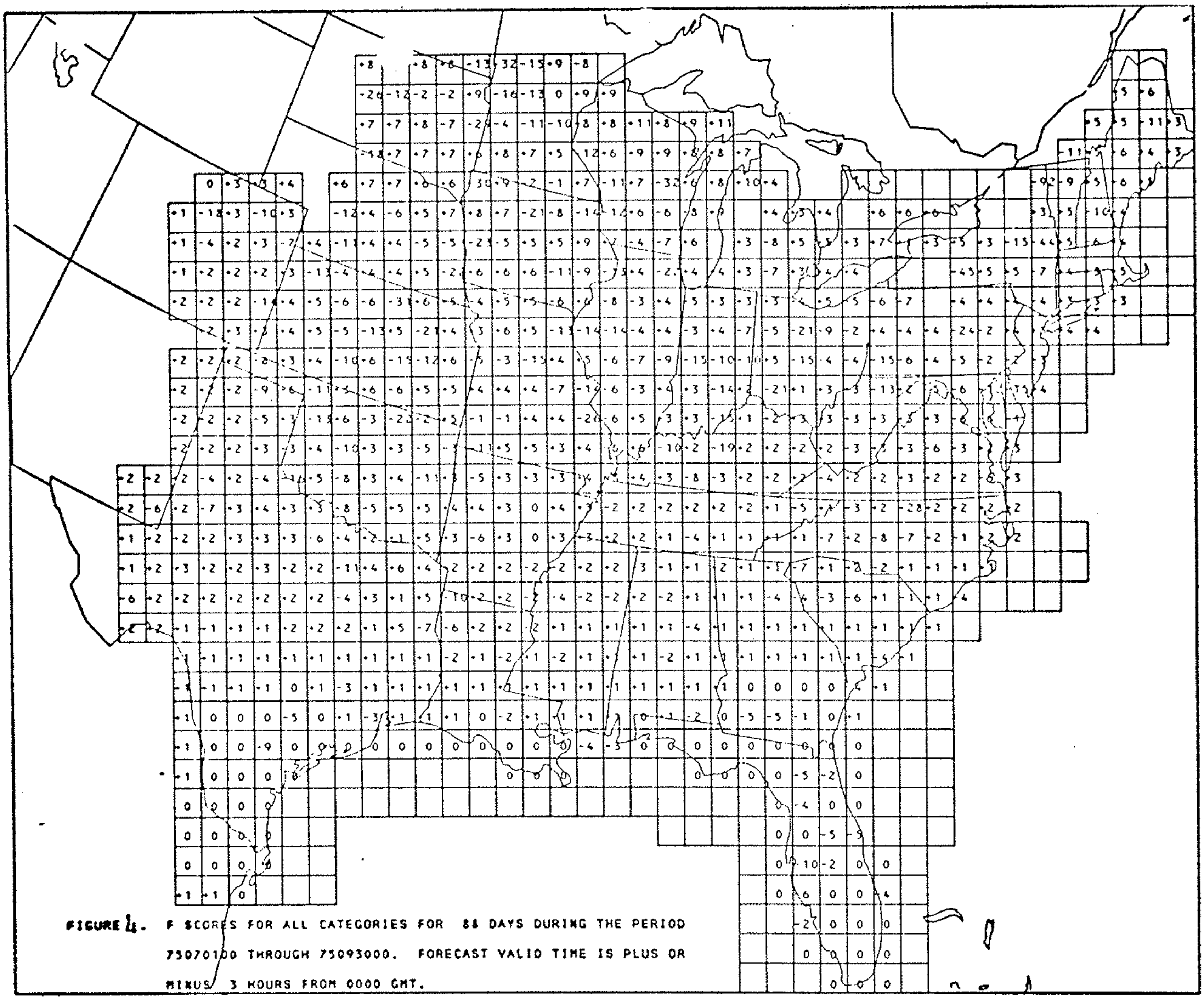

FIGURE 4. F SCORES FOR ALL CATEGORIES FOR 88 DAYS DURING THE PERIOD 75070100 THROUGH 75093000. FORECAST VALID TIME IS PLUS OR MINUS 3 HOURS FROM 0000 GMT.

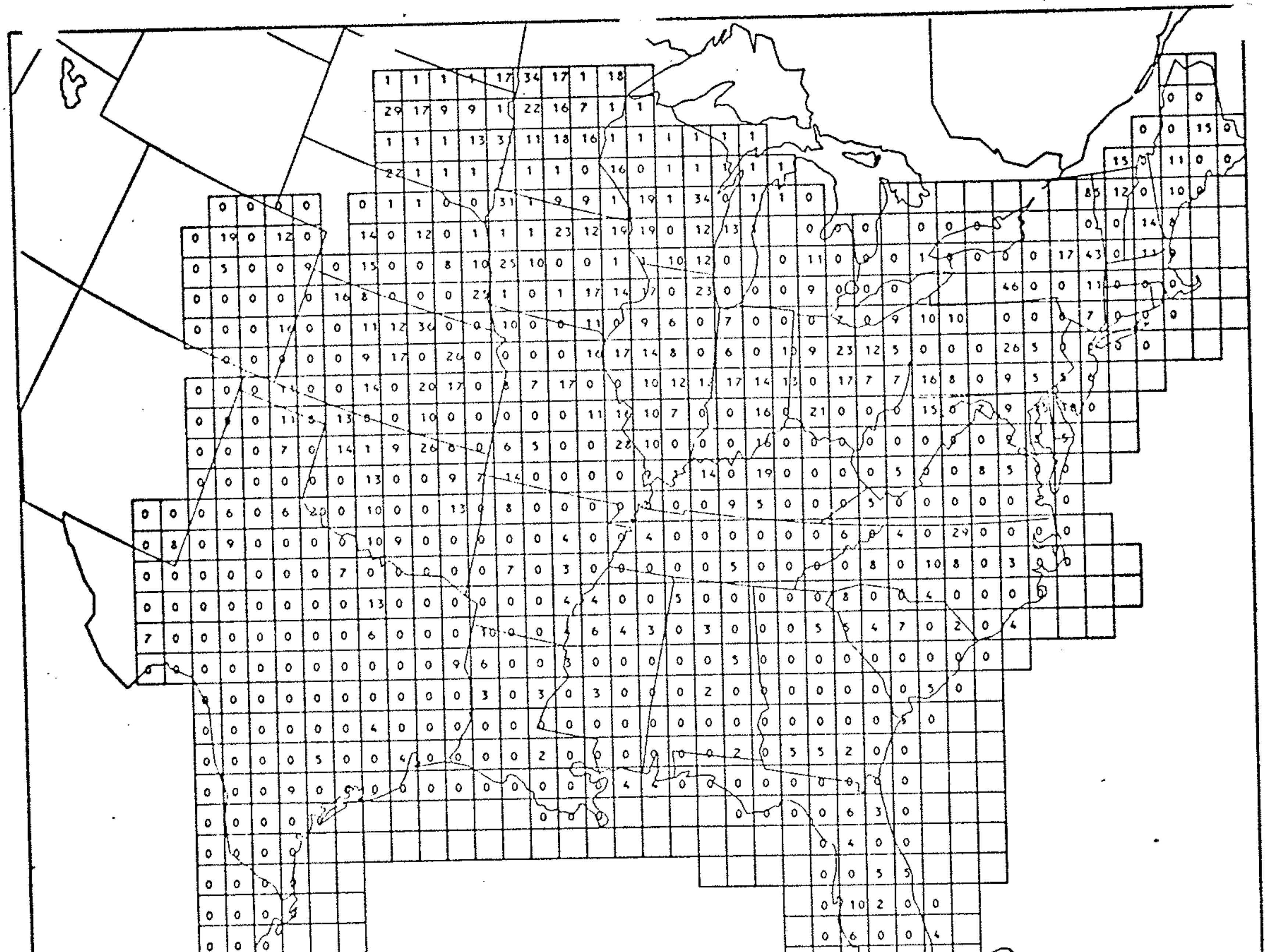

FIGURE 5. P SCORES FOR ALL CATEGORIES FOR 88 DAYS DURING THE PERIOD 75070100 THROUGH 75093000. FORECAST VALID TIME IS PLUS OR MINUS 3 HOURS FROM 0000 GMT.